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Inconsistency in Savings Pattern

Is there an Endogeneity Bias?

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Abstract

Traditionally, the difference between income and expenditure reported in household surveys is used for estimation of savings at the household level. However, persistent deviation in consumption–income ratios by household income brackets raises questions about both the quality of data and the estimation method employed. This paper provides statistical evidence to accentuate the endogeneity bias, which is connected with the choice of welfare proxy for ranking process, in savings estimates by income groups. Also, two different estimators for households spending behaviour are discussed and the statistical properties of their difference are derived by the delta method.

Keywords: households, measurement of welfare, savings

JEL classification: C42, D10

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1 Introduction

The volume of private savings is an issue of importance to both economic research and the public policymaking process. The effectiveness of savings tax incentives and government involvement in pension provision seems to depend on the propensity to consume by various population groups.

A number of studies, aimed at portraying the trend of saving and consumption behaviour by members of different income brackets, found a perpetual saving pattern; while the savings rate is negative for the lowest income groups (who tend to consume at least twice as much as their reported earnings), it records a sharp increase as income levels rise (see McKay 2000, Deaton 1998 and Butelmann and Francisco 2000 for developing countries, Martini *et al*. 1996 and Denizer *et al*. 2002 for transitional economies). The trend is present in survey data for both developed and developing countries (see the tables in the Appendix for evidence from New Zealand, USA, Chile, Bulgaria, Hungary, Poland and Belarus). A glance at the Appendix Tables will show the dramatic skewness in consumption–income ratios across the income deciles. Estimation of savings for the same survey data by expenditure deciles shows a reverse trend – the richest deciles decumulate their assets and the poorest accumulate them.[1]

A natural source of explanations for this inconsistency of savings estimates lies in the method of savings data assessment. In most cases savings are estimated by residuals of income and expenditure, both at household and aggregate country level. Measurement errors in income or consumption values are routinely blamed for the inconsistency of savings estimates by income brackets. 'Households who overstate their incomes will also, on average, overstate their savings, while households who overstate their consumption expenditure will correspondingly understate their saving' (Deaton 1998: 31).

Another interpretation of the measurement errors in income indicators is based on the permanent income consumption theory. Recorded income is considered to be observed as transitory income, which is an indicator of unobserved true permanent income. Therefore transitory income could understate or overstate the true permanent income. But 'empirically the effect is far too large to be explained by this phenomenon' (Gravelle 2002: 3). The long run divergence between income level and spending rate, especially for low income groups is not considered sustainable and a number of publications from various government agencies also cast doubt on the validity of the observed relationship between income and expenditure in survey data.[2]

Sabelhaus and Groen (2000) challenge the proposition that smoothing consumption behaviour could be responsible for the notorious skewness of saving estimates by income groups. They tested the assumption that deviation between currently measured transit income and permanent income could explain the estimated spending behaviour pattern. The authors, using cross-sectional income–expenditure data, show that the permanent income hypothesis could not explain skewness in savings estimation and conclude that the

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1 Both income and expenditure are considered to be relevant proxies for permanent income, while for many cases, consumption is seen as a better indicator.

2 For example see Congressional Budget Office (2000).

pattern of income-consumption ratio is 'significantly affected by non-random income measurement error or other anomalies' (Sabelhaus and Groen 2000: 431).

Such confusion regarding the unsustainable differences in the income–expenditure ratio makes it difficult to use savings estimates by income groups for purposes of public policy analysis. The aim of this paper is to develop an illustrative statistical model for accentuating endogeneity bias connected with the welfare proxy choice for ranking process which can result in misleading saving estimations by well-being deciles.

Our main finding is that it is the ranking process that could cause the skewness of the savings estimates even without non-random measurement errors. Our analyses shows that the lower the degree of correlation between reported income and expenditure, the higher is the expected difference in saving behaviour estimates over income groups. And even in the case when expected savings by well-being groups and by the sample population as a whole are both equal to zero, a different proxy choice for ranking process would lead to significantly different (negative or positive) savings estimations for corresponding groups of the same income bracket. The use of combined deciles is proposed as one possible solution for eliminating the negative-effect of the ranking process.

Also, we show that in order to reconcile the income and expenditure aggregates, it would be useful to employ two separate estimators – the conventional ratio of the means of total income to total expenditure and the expected rate of income to expenditure within the sub-sample. Due to its contrasting statistical properties, the second estimator could help to clarify the nature of systematic deviations between income and expenditure across well-being deciles. The delta method approximation is employed to derive statistical properties of the difference between these two estimators. Data from the Russian Longitudinal Monitoring Survey (RLMS), round 9, is used to provide an empirical application of the method.

2 Endogeneity bias in savings estimates

In a balanced budget account for each household in a survey, the difference in income and expenditure values should be ideally compensated by the measurable difference in net assets. However, the definition of net assets changes depending on the particular application.[3] An established practice in public policy research is to estimate savings by taking the difference between recorded household income and expenditure over a given period of time (see Deaton 1998, Martini *et al*. 1996 and the references therein). Obviously, the factors determining the possible accuracy of savings estimates depend upon the relative consistency of recorded household income and expenditure aggregates.

Although income and expenditure[4] are both considered relevant proxies of household well-being status, the savings estimates may be sensitive to the choice of the proxy due to the method of saving measurement used. This expected bias can be illustrated using RLMS data for the Russian Federation. The results are shown in Table 1.

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3 See discussion in Browning and Lusardi (1996).

4 There is a common understanding that for survey data in developing countries consumption data are more relevant to welfare measurement.

Table 1 Household income, expenditure, and saving by income and expenditure deciles in Russia, 2000

By expenditure decile				By income decile				Saving for
	Income	Expenditure	Saving		Income	Expenditure	Saving	pooled data
1	1 070	647	424	1	464	2 557	-2 093	-835
2	1 522	1 242	280	2	979	1 697	-718	-219
3	1 999	1 754	245	3	1 379	2 916	-1 537	-646
4	2 601	2 268	333	4	1 847	3 003	-1 156	-412
5	2 860	2 846	14	5	2 323	3 846	-1 523	-755
6	3 472	3 580	-108	6	2 902	4 311	-1 409	-759
7	4 197	4 512	-315	7	3 654	5 767	-2 113	-1 214
8	4 956	5 841	-885	8	4 689	5 531	-842	-864
9	6 193	7 889	-1 696	9	6 281	7 563	-1 282	-1 489
10	9 340	19 000	-9 660	10	14 000	12 000	2 000	-3 830
Total	3 819	4 906	-1 087	Total	3 819	4 906	-1 087	-1 087

Notes: The decile averages of income and expenditure of households are calculated first by expenditure and then by income deciles. For each decile of the population, the difference between the means of income and expenditure is used for the estimation of savings.

Sources: Author's calculation using Russian Longitudinal Monitoring Survey (RLMS), round 9, figures and price indexes of Russian Ministry of Statistics (GosKomStat).

As shown in Table 1, saving estimations vary significantly by deciles and by choice of well-being proxy. Based on the data, one could infer that households with relatively higher expenditure tend to dis-save while the households with higher reported income tend to save considerably or at least under-report a smaller part of expenditure (see Deaton 1998 and Martini *et al*. 1996). But a large part of this difference in savings estimates, emanating from the corresponding well-being status group, might be explained by the fact that inference about the amount of savings by well-being groups is biased.

The following statistical model can demonstrate the intuition for that effect. Let us assume an economic process which generates the same true unobservable permanent well-being status for all households; we further assume that observable realizations of that status (e.g. transitory income and expenditure variables) are randomly distributed around the real well-being with the same variances.[5] The society that generates the process has zero savings on aggregate, and any randomly selected group from this

5 The difference between true well-being and measurable indexes could be caused by numerous economic and social factors, specific to a particular survey and a particular population under consideration.

population would also have zero expected savings. The income and expenditure are measurable realizations of the stochastic process and can be either higher or lower than the unobservable unique underlying welfare value. For simplicity, we consider society to have only two major welfare groups (note that we do not know the underlying real well-being distribution). If we use income as the well-being proxy, observations with larger values fall into the upper group, while realizations of the same underlying process, which happen to be less in value, fall in the lower group. Therefore, the estimation of the sub-samples' savings based on a chosen proxy can bring us to a conclusion that the high-income households have positive savings while high expenditure households have negative savings. Due to the biased well-being sub-sample selection process, our estimation of saving based on the income (expenditure) proxy is positively (negatively) biased in the higher income level group and negatively (positively) biased in the lower level group.

Indeed, let us consider income and expenditure values being random variables (y and x, respectively) distributed around the permanent well-being status. Since we are choosing x or y as a proxy to present the real well-being status, given that x and y are not perfectly correlated we face an endogeneity problem for savings estimation by welfare groups. The value of the bias tends to increase in directions away from the mean and depends on the statistical properties of the joint distribution function of income and expenditure. To indicate the possible effect of such endogeneity bias we need to derive the expected value of the saving estimator and compare it with the true savings in our statistical model, which is zero for any randomly selected group.

Let us assume that x and y has a joint bivariate normal distribution, having equal means $\mu_x = \mu_y = \mu$,

μ_y is the expected mean of income recorded by the sample of household

μ_x is the expected mean of expenditure reported by the sample of household.

If a given set of observations for a decile j, what would be the expected savings for that specific decile?

According to the properties of conditional expectation function of x given y_i, for the bivariate normal distribution of random variables y and x:

$$\mathrm{E}\langle x \,|\, y_i \rangle = \mu_x + \rho \frac{\sigma_x}{\sigma_y}\left(y_i - \mu_y\right)$$

ρ is the correlation coefficient of x and y

σ_x, σ_y are standard deviations of x and y, respectively.

We develop an n-sized sub-sample based only on the specific observations for which values of y_i lie within a certain range j, $i = \{1, 2, ..., n_j\}$ is the number of observations within that sub-sample j.

The conditional expectation of the difference between y and x (estimated savings) within the sub-sample j of n_j observations can be written as:

$$\mathrm{E}\left\langle y-x\middle|Y_j\right\rangle=\frac{\sum_i y_{ij}}{n_j}-\frac{\sum_i \mathrm{E}\left\langle x_{ij}\middle|y_{ij}\right\rangle}{n_j}=\frac{\sum_i y_{ij}}{n_j}-\frac{\sum_i\left(\mu_x+\rho\frac{\sigma_x}{\sigma_y}\left(y_{ij}-\mu_y\right)\right)}{n_j}$$

Now, since $\mu_x=\mu_y=\mu$

$$\mathrm{S}_{yj}=\mathrm{E}\left\langle y-x\middle|Y_j\right\rangle=\left(\frac{\sum_i y_{ij}}{n_j}-\mu\right)\times\left(1-\rho\frac{\sigma_x}{\sigma_y}\right) \tag{1}$$

correspondingly,

$$\mathrm{S}_{xj}=\mathrm{E}\left\langle y-x\middle|X_j\right\rangle=-\left(\frac{\sum_i x_{ij}}{n_j}-\mu\right)\times\left(1-\rho\frac{\sigma_y}{\sigma_x}\right) \tag{2}$$

where X_j and Y_j is a subset of random variables x and y, respectively, assigned to the sub-sample j.

In general, $\mathrm{S}_{yj}\neq\mathrm{S}_{xj}$. This means that the expected value of savings is not equal for the corresponding deciles by alternative welfare proxies, unless the two variables, x and y, are perfectly correlated ($\rho=1$) and have similar variances $\sigma_y=\sigma_x$,

$$1-\rho\frac{\sigma_y}{\sigma_x}=0 \tag{3}$$

Only then the expected saving in equations (1) and (2) would be equal to zero for every decile regardless of the choice of well-being indicator.

The correlation between income and expenditure plays a crucial role in the degree of skewness of the spending pattern by income groups. As the value of the correlation moves away from unity, as happens in real household surveys (e.g. in RLMS data the value is about 0.3), the sign of expression (3) is likely to be positive. Thus, the sign of expected savings for the sub-sample depends on the position of the conditional observations relative to the mean (in the sub-sampling process by deciles on the number of welfare index decile). If the average value of the income (expenditure) in the sub-sample is greater than the mean of the random variable (e.g. belongs to the upper deciles), then,

$$\frac{\sum y_{ij}}{n_j}>\mu\left(\frac{\sum x_{ij}}{n_j}>\mu\right)$$

and, correspondingly, the expected saving estimations (1) would be positive (negative)

$$\mathrm{S}_{yj}>0\qquad\left(\mathrm{S}_{xj}<0\right)$$

Hence, the choice of the particular proxy of well-being determines both the sign and the magnitude of a bias of savings estimated.[6]

Two key points come with the formula. First, the less the correlation between income and consumption, the bigger the expected skewness. Second, peripheral decile estimations suffer more from endogeneity bias as the expected estimation bias increases at the upper and lower end of the deciles, while middle positioned deciles tend to have no bias at all since they are closer to the expected mean of welfare proxy. The notorious skewness of savings rates in peripheral deciles could be explained by this statistical model. This finding corresponds to trends in estimates for different countries presented in the Appendix.

As measurement errors of both income and expenditure variables in our analyses are distributed randomly around the real well-being status with comparable variances, the endogeneity bias of the savings estimator can be diminished by pooling observations from the corresponding deciles of two sub-sample processes into one combined decile. The estimator for the corresponding well-being level would be the average of saving figures for this pooled decile

$$S_j = \frac{S_{yj} + S_{xj}}{2}$$

The data from each observation are included twice in the estimation in the alternative well-being deciles. In the framework, where income and expenditure have bivariate normal distribution, that saving estimator is unbiased for every income bracket.

3 Systematic measurement errors and aggregation of savings rates

In the previous section, we assumed that there is no systematic pattern of the deviation between income and expenditure aggregates by well-being groups and the difference in savings estimation by corresponding deciles is mostly due to a non-random selection process. But real surveys might have systematic inconsistency between these two values which tend to be correlated with true well-being status, that could lead to biased estimation of savings both at aggregate and sub-group level.

A number of recent household surveys found savings to be negative for a majority of households in several developing countries (McKay 2000; also see the household survey results from Côte d'Ivoire, Ghana and Mauritania as reported in Johnson *et al*. 1990). Although it is possible for some individual households to dis-save during a given period, it is unlikely that in the long run the household sector, as a whole, will have significant dis-saving. This led Johnson *et al*. (1990) to conclude that a significant understatement of income or an overstatement of expenditure characterizes household surveys in developing countries.[7]

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6 The bias tends to persist if other variables, highly correlated with income and expenditure, have been chosen as welfare proxy.

7 According to Atkinson and Micklewright (1983), a similar problem also exists in the developed countries.

Meanwhile, compatibility of total income and expenditure over population tells us little about the extent to which expenditure and income figures are consistent across different household groups in the population presented and the pattern of assets accumulation by different income groups.

According to some household survey studies, while the value of total expenditure exceeds that of total income, the majority of population still reports positive savings. Indeed, coherence of the income–expenditure figures at household level over the sample population appears to be sensitive to two main factors – willingness of respondents to disclose real income and expenditure, and the extent of systematic methodological measurement errors. The latter significantly depends on the definition of household income and expenditure aggregates as well as the method used for constructing the values of included components, imputation technique, etc. (Deaton and Zaidi 2000).[8] The problem is exacerbated with the existence of a large non-monetized sector as it is more difficult to construct money-metric income and expenditure aggregates and corresponding savings. Many of these factors contribute to the deviation between income and expenditure and tend to correlate with the position of household on the living standards ladder.

Again, it follows from section 2 that the ratio of income and expenditure at aggregate level could be measured by a ratio of *means* of income and expenditure (see McKay 2000 for a survey):

$$r = \frac{\mu_y}{\mu_x} \tag{4}$$

However, this estimator gives no clear perception about the incidence of the income–expenditure relationship. Given that income and expenditure are randomly distributed, outliers significantly affect the mean estimator, especially in the tails of the distribution.

To explore spending behaviour at the micro level, an alternative estimator is the rate of recorded income and expenditure within selected sub-sample:

$$\mathrm{E}\left(\frac{y}{x}\right) = \mathrm{mean}\left(\frac{y}{x}\right) = \mu\left(\frac{y}{x}\right)$$

This estimator of the income–expenditure relationship does not usually coincide with the ratio of aggregated figures of income and expenditure. In what follows we present a statistical explanation as to why these two estimators tend to give different estimates of spending behaviour.

The statistical theory assumes that an expected difference between the two estimators depends on properties of mutual distribution of income and expenditure. To explore this

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8 Moreover, savings data for many developed countries are plagued with problems relating to the measurement of monetary value of items, disentangling private savings from collective ownership, persistent problems with estimation of private pension contributions and treatment of durable expenditure. See Lusardi *et al*. (2001).

further, we employ the delta method approximation[9] for the expectation of the ratio of two random variables, *x* and *y*:

$$\mathrm{E}\left(\frac{y}{x}\right)=\frac{\mu_y}{\mu_x}+\frac{1}{\mu_x^2}\times\left(r\sigma_x\sigma_x-\rho\sigma_x\sigma_y\right) \text{ (approximately)} \quad (5)$$

where $r=\frac{\mu_y}{\mu_x}$ and then (approximately)

$$\text{if } r\sigma_x\sigma_x-\rho\sigma_x\sigma_y>0\,|\,(<0) \quad \text{then} \quad \mathrm{E}\left(\frac{y}{x}\right)>\frac{\mu_y}{\mu_x}\,|\left(<\frac{\mu_y}{\mu_x}\right) \quad (6)$$

Let us assume that the income and expenditure means and variances have similar values: $\mu_x \approx \mu_y$, $\sigma_x \approx \sigma_y$ then the sign of inequality (6) is dependent on the correlation coefficient ρ. If *x* and *y* are perfectly correlated (ρ = 1), the two estimators are both close to unity.

$$\mathrm{E}\left(\frac{y}{x}\right)\approx\frac{\mu_y}{\mu_x}\approx 1$$

The lower the correlation value, the higher the difference between the two estimators would be. For example, the ratio of average income to average expenditure for the RLMS data equals 0.78 and shows negative savings. Given the value of ρ to be 0.3, we expect the rate estimator to be higher than the ratio. In fact, the rate estimator turns out to be about 1.07 indicating that the average household is likely to accumulate its assets.[10]

This finding has important real life applications. For example, one should be careful with the use of an income–expenditure ratio as an estimator of household spending behaviour. While aggregate figures could show that the populations decumulate their assets, the rate estimator could point to a positive value of savings for most households. Operating both estimators for separate groups within a population in order to find determinants provides an insight that may help to identify household groups with a similar income–consumption behaviour pattern.

4 Conclusion

Traditionally, the difference between income and expenditure reported in household surveys is used for estimation of savings at the household level. However, persistent deviation in consumption–income ratios by household income brackets raises questions about both the quality of the data and the estimation method employed. The contribution of this paper is two-fold. First, it provides statistical evidence that skewness in saving estimates by income groups could be caused by an endogeneity bias in the ranking process, even in the absence of systematic measurement errors. The endogeneity bias is

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9 The delta method expands a function of random variables about their means. For this particular case we used a 2-step Taylor approximation. For further explanation see Rice (1995).

10 Author's calculation based on the RLMS data, round 9.

related to the choice of welfare proxy for the ranking process and can emanate the misleading estimation of savings by well-being deciles. The correlation between income and expenditure figures over the population is the main measurable indicator of the degree of possible bias in the savings estimates by income groups. The use of combined deciles is proposed as one possible solution for eliminating the negative effect of the ranking process. Second, two different estimators for households spending behaviour are discussed and the statistical properties of their difference are approximated by the delta method. Therefore, care should be taken with using an income–expenditure ratio as an estimator of household spending behaviour to avoid skewness. Rather the rate and the ratio estimates together may help identify similarity in patterns of behaviour.

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Appendix

Table A1 New Zealand.
Household income, expenditure and saving by income and expenditure deciles

By income decile

Decile	(1) Income	(2) Expenditure	(3) Saving	% ratio (3)/(1)
1	8540	14341	-5801	-67.9
2	14188	16094	-1906	-13.4
3	17698	18461	-764	-4.3
4	21807	21743	64	0.3
5	26428	24597	1831	6.9
6	31400	27485	3915	12.5
7	36933	30582	6351	17.2
8	43686	34509	9177	21.0
9	53357	39202	14155	26.5
10	86465	51607	34858	40.3
All	34049	27862	6187	18.2

(Table A1 *Continues*…)

(Table A1 …*Continued*)

By expenditure decile

Decile	Income	Expenditure	Saving	% ratio (3)/(1)
1	14792	8007	6785	45.9
2	19123	12584	6539	34.2
3	22330	15933	6396	28.6
4	25873	19156	6716	26.0
5	29891	22400	7491	25.1
6	33842	25882	7960	23.5
7	37448	29922	7526	20.1
8	42491	34987	7504	17.7
9	48761	42466	6295	12.9
10	65951	67288	-1338	-2.0
All	34049	27862	6187	18.2

Note: Income US$ million.

Source: Gibson and Scobie (2001).

Table A2 USA.
Households' pattern of consumption, by income group, 1998

	Total consumption as a % of after-tax income: Based on expenditure data
Quintile 1	235.1
Quintile 2	144.3
Quintile 3	121.3
Quintile 4	105.4
Quintile 5	70.5

Source: Congressional Budget Office (2000).

Table A3 Chile.
Average rate of saving by quintiles, 1996–97

	by income group (%)	by expenditure group (%)
Quintile 1	-37.5	9.9
Quintile 2	-17.6	-1.0
Quintile 3	-5.2	-7.7
Quintile 4	1.4	-18.1
Quintile 5	12.5	-29.4
Total	-9.3	-9.3

Source: Butelmann et al. (2000).

Table A4 Bulgaria, Hungary and Poland.
Savings rates by income group: mean

	Bulgaria	Hungary	Poland
Quintile 1	-0.008	-0.040	-0.021
Quintile 2	-0.036	-0.021	0.041
Quintile 3	-0.020	-0.015	0.076
Quintile 4	0.027	0.007	0.106
Quintile 5	0.122	0.080	0.212

Source: Denizer *et al*. (2002).

Table A5 Belarus.
Average cash income and cash expenditure of households of households ranked by quintile of cash income (monthly average across 1995)

	(1) Average cash income	(2) Average cash expenditure	% ratio (1)/(2)
Quintile 1	427	700	61
Quintile 2	780	1064	73
Quintile 3	1100	1349	82
Quintile 4	1527	1725	89
Quintile 5	2625	2795	94

Note: In ’000 BY rubles
Source: Martini *et al*. (1996).